

ABSTRACT FOR THE GENERAL PUBLIC

Vascular endothelium-supporting materials: Understanding the structural and physicochemical requirements (RESTORE)

The circulatory system and the blood are the basic system of internal transport in our body. It transports oxygen and glucose, essential for maintaining the body functions, as well as waste-products of metabolism. Because blood carries oxygen, it has strong oxidizing properties and should not leave the vascular bed, as leaking blood can destroy our body cells. In addition, if a vessel is damaged and blood leaks, the clotting process begins immediately to block the leakage.

Due to the properties of blood, the only cells predisposed to come into contact with it are endothelial cells, which line our entire circulatory system from inside. They withstand the contact with the blood and actively block the clotting process all the time. Unfortunately, sometimes our circulatory system becomes damaged, most often by inflammatory processes occurring in the walls of blood vessels. This can lead to the blocking of blood vessels, which deprives certain body regions of access to oxygen and nutrients and can lead to cell death. If a vessel of the myocardium is blocked, it can lead to myocardial infarction and even death. Unfortunately, cardiovascular complications are one of the main causes of death among European citizens. For this reason, if a severe narrowing of the blood vessel occurs, it should be surgically repaired or replaced as soon as possible. Ideally, fragments of blocked or damaged vessels should be replaced with new ones. Usually blood vessels taken from the patient's extremities are used for this purpose, but this requires additional surgery, and it is not always possible to find a part of the vessel in good enough condition. Vascular prostheses exist nowadays, but their use causes a number of problems. Blood components, specifically the proteins and thrombocytes, are adsorbed and activated upon contact with material other than endothelial cells. This leads to the formation of clots on the surface of the grafts and to the presence of activated platelets in the bloodstream, which can cause the formation of microclots and block small blood vessels, for example in the brain. This problem is particularly acute in the case of small vascular prostheses with an internal diameter of less than six millimeters. The ideal solution would be to create hybrid scaffolds, i.e. made of synthetic materials but permanently covered with living endothelial cells. In order to create such structures we must first examine the process of colonization and adhesion of endothelial cells to the surface of the biomaterial. The aim of this project is to produce prototype prostheses of blood vessels and to investigate the process of their seeding by endothelial cells. These scaffolds will be structurally mimicking the blood vessel wall, being porous and made up of nano/micro polymer fibres on the outside. The surface of the scaffolds will be modified to minimize protein adsorption and platelet activation. In addition, by chemical modification, nanostructures will be created on the surface of the scaffolds, recognizable by endothelial cells as natural places of their attachment. These structures will present different amino acid sequences known as adherent sequences. In order to create such coating structures, we will study a number of methods of polymer surface modification and test different amino acid sequences. The processes of surface modification, interactions of the modified surface with blood and the responses of endothelial cells to the surfaces will be investigated.

We hope that the results of this project will contribute to the future development of hybrid vascular prostheses inhabited by the patient's own cells. This will allow for easier and more effective treatment of blocked blood vessels.